Calibration method for carrying out multiport measurements on semiconductor wafers

Patent Claims

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1. Method for calibrating a vectorial network analyser having n measurement ports and at least 2n measurement locations (n>1) by successive measurement of the reflection and transmission parameters at k = sum

10 (n-i) for (i = 1, 2, ..., n-1) or n-1 different two-port calibration standards, which are connected between the measurement ports in any desired order and must all have a transmission path, and three different n-port calibration standards, which are connected between the

15 measurement ports in any desired order and are permitted to have no transmission, by mathematical determination of error coefficients of the network analyser with the 10-term method in the k-fold application and measured two-port calibration standards and by mathematical

20 determination of the scattering matrix $[S_x]$, in which the errors are corrected, with the 10-term method **characterized in that**

a) the first k calibration measurements are carried
25   out at a two-port, which is realized by means of the direct connection of the measurement ports (through connection, T = Thru) or a short matched line (L = Line) of known length and attenuation, and which is connected between each of the k pos-
30   sible measurement port combination,

b) a further calibration measurement is carried out at an n-fold one-port (n-one-port), which is realized by means of n known, if appropriate differ-
35   ent, impedances (e.g. so-called wave terminations with 50 Ω, M = Match),

c) a further calibration measurement is carried out at an n-one-port, which is realized by means of n

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unknown greatly reflective terminations (R = Re-
flect), which are similar to short circuits (S =
Short),

5 d) a further calibration measurement is carried out
at an n-one-port, which is realized by means of n
unknown   greatly   reflective   terminations
(R = Reflect) which are similar to open circuits
(O = Open) and

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e) the reflexion accounts of the n-one-ports, which
is realized by means of n unknown greatly reflec-
tive terminations which are similar to open cir-
cuits or to short circuits, are mathematical de-
15   terminated.

2.   Method for calibrating a vectorial network ana-
lyser having n measurement ports and at least 2n meas-
20 urement locations (n>1) by successive measurement of
the reflection and transmission parameters at n-1 dif-
ferent two-port calibration standards, which are con-
nected between the measurement ports in any desired or-
der and must all have a transmission path, and three
25 different n-port calibration standards, which are con-
nected between the measurement ports in any desired or-
der and are permitted to have no transmission, by
mathematical determination of error coefficients of the
network analyser with the 7-term method in the n-1-fold
30 application and measured two-port calibration standards
and by mathematical determination of the scattering ma-
trix $[S_x]$, in which the errors are corrected, with the
7-term method, **characterized in that**

35 a) the first n-1 calibration measurements are carried
out at a two-port, which is realized by means of
the direct connection of the measurement ports
(through connection, T = Thru) or a short matched
line (L = Line) of known length and attenuation,

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and which is connected between a reference measurement port and the remaining ports (n-1),

b) a further calibration measurement is carried out at an n-one-port, which is realized by means of n known, if appropriate different, impedances (e.g. so-called wave terminations with 50 Ω, M = Match),

c) a further calibration measurement is carried out at an n-one-port, which is realized by means of n unknown greatly reflective terminations (R = Reflect), which are similar to short circuits (S = Short),

d) a further calibration measurement is carried out at an n-one-port, which is realized by means of an unknown greatly reflective termination (R = Reflect) which are similar to open circuits (O = Open) and

e) the reflexion accounts of the n-one-ports, which is realized by means of n unknown greatly reflective terminations which are similar to open circuits or to short circuits, are mathematical determinate.

3. Method for calibrating a vectorial network analyser according to Claim 1, **characterized in that**

a) n>2 holds true,

b) the further calibration measurement is carried out at a one-port, which is realized by means of a known impedance (e.g. so-called wave termination with 50 Ω, M = Match), instead at a n-one-port, which is realized by means of n known impedance.

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4. Method for calibrating a vectorial network analyser according to Claim 2, **characterized in that**

a) $n>2$ holds true,

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b) the further calibration measurement is carried out at a one-port, which is realized by means of a known impedance (e.g. so-called wave termination with 50 Ω, M = Match), instead at a n-one-port,

10 which is realized by means of n known impedance.

5. Method for calibrating a vectorial network analyser according to Claim 1 or 2, **characterized in that**

15 the further calibration measurement is carried out at a $(n-i)$-one-port, wherein $i<n$, which is realized by a known impedance (e.g. so-called wave terminations with 50 Ω, M = Match), instead at a n-one-port, which is realized by means of n known impedance.

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6. Method for calibrating a vectorial network analyser according to one of the Claim 1 to 5, **characterized in that** one of the greatly reflective terminations

25 is known.